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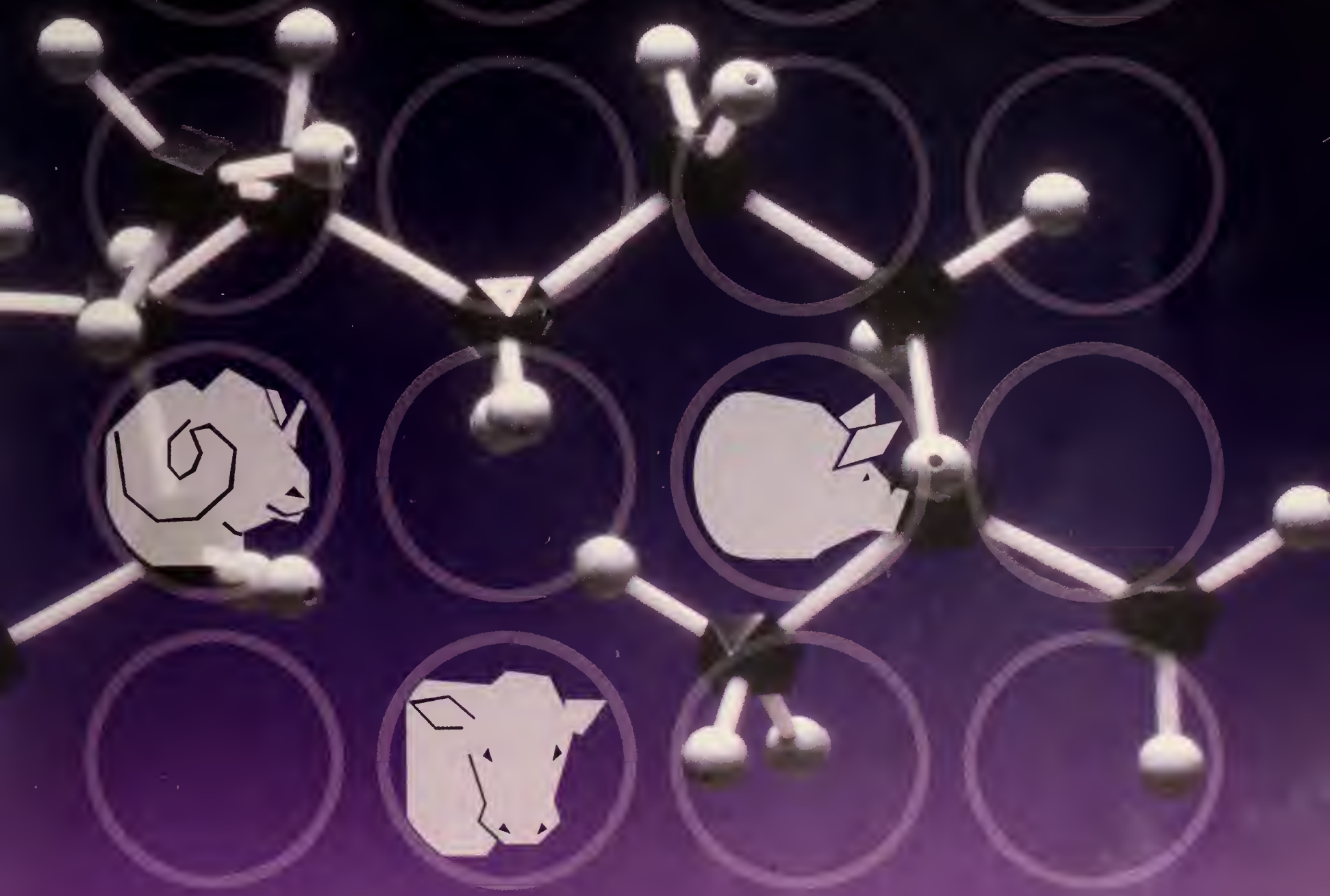
CANADA'S COUNTRY REPORT on FARM ANIMAL GENETIC RESOURCES



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CANADA'S COUNTRY REPORT
on
FARM ANIMAL GENETIC RESOURCES

to THE FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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2003

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Preface

Canada was an early signatory of the 1992 Convention on Biological Diversity arising from the United Nations Conference on Environment and Development, popularly known as the Rio Conference. For the first time, farm animal genetic resources became subject matter under a legally binding international treaty. In 1993, the Food and Agriculture Organization developed its Global Strategy for the Management of Farm Animal Genetic Resources. As part of this strategy, the Intergovernmental Technical Working Group on Animal Genetic Resources for Food and Agriculture recommended that the Food and Agriculture Organization of the United Nations co-ordinate the development of a Report on the State of the World's Animal Genetic Resources. The Food and Agriculture Organization and its intergovernmental Commission on Genetic Resources for Food and Agriculture subsequently extended an invitation to its 161 member countries to submit country reports, with the intent that these be assembled into regional reports as the basis of a report on the state of the world's farm animal genetic resources. The invitation was accepted by Canada.

The genetic variation that has accumulated and become distinctly Canadian is used by Canada's agriculture to adapt to continuously changing climatic, economic, and social conditions. Availability of this variation will be necessary for Canadian producers to address all of the key components of the Agriculture Policy Framework, including Business Risk Management, Food Safety and Quality, Science and Innovation, and Renewal.

Appreciation is expressed to the authors and to members of the Ad Hoc Advisory Committee for their efforts in producing this report which not only responds to an international obligation, but provides for reflection within Canada on the importance of farm animal genetic resources to our continued prosperity.

Bob Speller

Minister of Agriculture and Agri-Food

2003

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Executive Summary

Canada, although one of the world's largest countries, uses only 6.8% of the landmass for agriculture. Primary agriculture employs just 3% of the population, and contributes an equal percentage to the country's economy. Most of Canada's animal agriculture is intensive and productive. Principal animal species used for agriculture are cattle, swine, sheep, chickens, turkeys, and horses, with lesser numbers of goats, ducks, geese, and rabbits. Species native to North American, i.e. bison, elk, deer, mink, and foxes, in addition to turkeys, are also farmed.

Most Canadian animal industries use a limited number of breeds or strain crosses. Canada is home to the Canadienne cow, Canadien horse, and Newfoundland pony which developed in Canada over many years. Planned crosses have produced new breeds, some of which are, or have been, commercially important.

Very few animals are kept in public Canadian institutions as a reservoir of genetic resources. The provinces of Newfoundland and Labrador and of Quebec contribute to maintaining breeds that originated in these provinces. Two universities keep small collections of heritage chicken breeds. A federal research site houses several lines of chickens and Japanese quail. In addition, at least two universities have cryogenically preserved tissue from discarded chicken lines. Two non-governmental organizations are concerned with farm animal genetic resources. Rare Breeds Canada, affiliated with Rare Breeds International, represents grassroots conservationists and has played an important role in public education. The Canadian Farm Animal Genetic Resources Foundation focuses on raising awareness of governments and industry and encouraging liaison with researchers. Canadian animal industries do not directly conserve genetic resources, although artificial insemination centres save semen from dairy bulls, and a few companies keep genetic material when there is a perceived commercial benefit.

The Canadian Livestock Records Corporation and breed associations maintain pedigree records of registered breeds. Surveys of sheep, goat, swine, and cattle resources were conducted in the 1990s, and surveys of poultry and laboratory animal stocks were done in the past. Rare Breeds Canada monitors population sizes of minor breeds. Performance recording programs are now almost entirely privatized, with many operated by breed associations. There is some molecular characterization of breeds or genes.

Farm animal genetic resources are economically significant in Canada. Animal products have traditionally been marketed as commodities which has encouraged the use of standardized animals. Canada's success in genetic improvement, its programs for pedigree verification, and its high health status have resulted in a significant international demand for Canadian genetic material. Currently, market differentiation is providing opportunities for specialized animal products which may encourage the use of a greater variety of animal breeds.

The demand for animal products is expected to increase both domestically and internationally and Canada can expect to participate in these expanding markets because of its reputation as a supplier of superior breeding stock. A growing awareness of animal welfare issues may lead to increasingly diverse production environments. Animal products are being used in non-traditional ways. Genetic variation will be needed for Canada to remain competitive and adapt to social change, climate change, and change in production environments.

The Animal Pedigree Act, Record of Performance programs, and programs to encourage the use of improved stock have contributed to the success of Canada's animal industries. Canadian poultry and dairy industries operate under a system of supply management, with quotas based on standardized products. Much of Canada's animal industry uses industrial environments, and voluntary codes of practice for cattle, swine, sheep, and poultry provide management standards.

Governments in Canada and the animal industries had generally considered that the variation that they require to adapt to change is available within the country or internationally. Recently, some representatives of the animal industries have expressed concern about diminishing genetic diversity in commercial populations. Civil society organizations play a role in providing information to the public and in keeping animals.

Canada currently does not have a specific infrastructure related to farm animal genetic resource conservation, but is in the early stages of establishing a national program. Animal breeding is taught at post-secondary educational institutions and may include a section on genetic resources. Relevant research is conducted at various establishments. Canadian animal industries and non-governmental organizations can also make significant contributions to an overall system. A national program would benefit the conservation and sustainable utilization of farm animal genetic resources. This could be entirely within government, entirely in the private sector, or more likely, as a collaboration among all stakeholders to help to establish goals and contribute to costs.

Any future Canadian program for conservation of farm animal genetic resources would require strong leadership. It would need to be able to liaise with all stakeholders, including industries, academics, governments, and non-governmental and international organizations. It would need to be able to manage information to link existing data bases and ensure that available information is captured and stored. It would need to have expertise in handling and storage of genetic material and it would need to have the capacity to increase this expertise through research. The group would need to be able to conduct research on the evaluation and use of genetic diversity. Animal holding facilities would be needed to allow collection of gametes, to support research, and as part of a rescue network. Finally, it must be able to conduct outreach programs and advocate for farm animal genetic resources with specialized groups, the general public, and public and private organizations. Either a single location, multiple diffuse locations, or more likely a central location with satellites that contribute specific facilities or expertise, would be needed to provide a focus.

Part 1. The State of Genetic Resources in the Farm Animal Sector

1.1 Overview of Canada's animal production systems and related animal biological diversity

Canada occupies most of the northern part of North America, mostly falling north of the 49th parallel. Canada is one of the world's largest countries, with a landmass of over 9 million km^2, much of which is in the Arctic or is otherwise unusable for agriculture. About 41 million ha (4.56%) of Canada's landmass is cultivated (cropping for food and feed, as well as fallow), with another 20 million ha (2.25%) in natural and improved pasture (Table 1). Most of Canada's population of 30 million people and the majority of its arable land is located within 300 km of the southern border. The population has increased by slightly less than 1% per year since 1991 (Table 2). This growth in population has been urban, and the rural population has steadily declined as farms have become larger and more mechanized. Canada consistently ranks among the best countries in the world to live according to economic and social indicators.

Primary agriculture employs 3% of the Canadian population (Table 2) and income from primary agriculture represents 3% of Canada's gross domestic product. Animal agriculture is responsible for 58% of the value of agricultural output (Table 3). Canada as a whole is not susceptible to food shortages, being largely protected by its relatively high income, diverse geography, and ability to produce sufficient food. Efficient transportation systems in southern Canada allow for easy movement of animals and products; costs are higher in northern and remote areas.

Governments own 21% of the land used in Canada for livestock production, a percentage that has declined slightly over the past 10 years (Table 4). Canada has nearly 250 000 farms, 57% of which have livestock (Table 5). Excluding those with total farm incomes less than $10K, the number of farms in Canada has decreased over the last decade as the size of farms has increased (Table 6). When 50% or more of income was obtained from on-farm sources, farm size averaged 424 ha compared to only 240 ha when farming contributed less than 50% of income.

In 1999, 152 000 of Canada's farms were owned by farming families in various categories according to business intentions, total income, and other factors (Table 7). Large and very large family farms derived a larger portion of their income from on-farm than from off-farm sources. Many of Canada's family farms are small or medium sized and generated the majority of income (73%) from non-farm sources. In 1999, nearly half of Canada's family farms were operated by farmers approaching or in retirement, or living on farms but generating almost all income from off-farm sources.

Canada can be divided into four principal farming regions, Atlantic Canada, Central Canada, the Prairies, and British Columbia (Table 8), that differ considerably in climatic conditions, soil characteristics, and population demographics. In Atlantic Canada, animals contribute 47% of farm income with 60% of the remaining derived from fruits and vegetables. Central Canada, including the St. Lawrence valley and Southern Ontario, has fertile soil and favorable climatic conditions, and produces 39% of

Canada's primary agricultural output, 51% from animal products (principally dairy, pork, beef, poultry). The Prairie provinces are known for producing small grains (primarily wheat, barley, and oats) with an increasing diversification into oilseeds (canola) and specialty crops (pulses and some spice crops). Beef cattle production is very important on the Prairies, and swine production has increased dramatically in recent years. Including poultry, dairy cattle, and sheep which contribute smaller amounts, animals generate 39% of farm income on the Prairies. Agriculture in British Columbia is concentrated in the Fraser and Okanagan Valleys and southern Vancouver Island. Farm animals, primarily dairy cattle and poultry, are produced in the Fraser Valley, whereas fruits are dominant in the Okanagan Valley. Beef cattle are kept extensively throughout the province. Farm animals are responsible for 45% of British Columbia's farm income.

The principal animal species (Table 9) kept for food, fibre and draft power in Canada are cattle (dairy, meat), swine (meat), sheep (meat, fibre, dairy), chickens (meat, eggs), and turkeys (meat). Lesser numbers of goats (meat, dairy), ducks (meat), and geese (meat) are kept. Horses are kept for a variety of purposes, including leisure, hormone production, meat, and draft. Rabbits (meat, fibre) are a very minor agricultural species, and llamas, alpacas, and donkeys are also kept in small numbers. There is purposeful farming of native North American animals, such as mink and fox (fur), bison (meat, skins), elk and deer (meat, skins, antlers), as well as harvesting of wild animals. A small population of domesticated reindeer of Siberian and Norwegian origin, derived from the Alaskan population, is kept in the MacKenzie River delta. The European wild boar is kept throughout southern Canada for meat and hunting, but numbers remain low.

Although animal industries tend to be cyclical in nature, the numbers of most farm animal species increased between 1991 and 2001 (Table 9). Beef cattle and swine production in Canada increased partly due to changes in domestic policy (removal of grain freight subsidies) and because of changes in international markets. Chicken broiler production and egg production increased largely to supply domestic demand. Production by dairy cattle has increased along with population growth, with a shift in consumption from whole milk to milk products such as cheese and yogurt.

The majority of Canadian animal agriculture is intensive, requiring high inputs of both capital and energy (Table 10). Some cattle and sheep are grazed extensively, considered as a medium input system. Controlled harvest of native wild ungulates – bison *(Bison)*, elk/wapiti *(Cervus)*, caribou *(Rangifer)*, deer *(Odocoileus)*, muskoxen *(Ovibos)*, sheep *(Ovis)*, moose *(Alces)* - by aboriginal populations represents a type of low input agriculture production system which has been commercialized to a small degree to support northern communities with few alternative forms of income. There is little subsistence farming in Canada. Commercial farms in Canada market all or nearly all of their production.

Canada is a net exporter of live and processed cattle and of swine (Table 11). The supply of chicken meat and eggs, turkey meat, and milk and milk products is controlled by marketing boards that regulate domestic production, with the Government of Canada controlling imports and exports. However, Canada exports and imports significant quantities of these commodities. In addition bison, sheep, horses, other poultry, rabbits, goats, and donkeys, are exported as meat, skins, or as live animals. Sheep, goats, waterfowl, horses, donkeys, and rabbits, or the products that they produce, are imported. Much of the international trade in live animals is a transfer of genetic material. Genetic resources (i.e. semen and embryos) of cattle, horses, pigs, and goats are also exported (Table 12).

1.2 Assessing the state of conservation of farm animal biological diversity

Breeds of farm animals

Most Canadian animal industries use a small number of standardized breeds with defined and stable phenotypes and known pedigrees that were originally developed elsewhere. Ninety-five percent of the dairy herd is made up of Holstein cows, with Ayrshires and Jerseys making up most of the rest. Artificial insemination is used almost exclusively, with a limited number of sire families represented. The beef industry was based primarily on the British breeds (Shorthorn, Hereford, Aberdeen Angus) until the late 1960s when many Continental European breeds were imported to increase size and muscling. Recently there has been a move back to smaller brood cows, in concert with the United States industry. The Angus breed is presently very popular, with other breeds developing black strains partly because of this. Approximately 40 beef breeds are recognized in Canada, but four pure breeds, Angus, Charolais, Hereford, and Simmental, represent approximately 90% of total registrations in Canada. Controlled cross-breeding programs continue to be important in the beef industry. Lines have been synthesized from existing breeds and are now also being used commercially. Swine of seven different breeds were registered in 2001, but 99.4% of these were in the Yorkshire, Landrace, and Duroc breeds, which are used predominantly by the swine industry either pure or in crossbreeding programs. These breeds, along with newly developed lines, continue to be used in crossbreeding programs, often without registration of the individuals. The sheep industry uses the Suffolk, Dorset, Katahdin and others in farm flocks, and the Columbia in range flocks, although many of these are not registered. There are more than 40 breeds of sheep in Canada, but many are held in small numbers. Sheep in Canada are used primarily for meat, but dairy production is increasing; sale of wool makes up only a small portion of producer income. The Canadian goat industry is relatively small, and at least ten breeds are present, with the Alpine, Nubian, and Saanen breeds being most important. There is a system in place for genetic improvement for dairy purposes. The goat meat industry has been increasing with the introduction of Boer goats. Horses are used for pleasure, equestrian (jumping, dressage, eventing) or Western disciplines (cutting and reining, rodeo, barrel racing), and various forms of racing and there has been a revival of interest in use of horses for draft power. A segment of the industry uses pregnant mares to produce hormones for human medicinal and cosmetic purposes. Horses may be slaughtered for meat, primarily for export. The poultry industry is the most industrialized of all Canadian animal industries. Strain crosses rather than breeds are used, with a small number of international companies involved in breeding.

Canada has a limited number of landrace breeds, which are traditional breeds kept for many generations with significant natural selection but no selection by professional breeders. The French government attempted to establish cattle in North America as early as 1518, but the animals imported at this time did not survive. The Canadienne breed of cattle was developed in the area that became the province of Quebec from stock imported in 1608 and 1610, with additional importations from Normandy and Brittany in the following decades. The Canadienne is known for producing milk with a high fat and protein content and for its ability to do well on relatively poor pasture. In 1995, only 105 pure Canadienne cattle were registered but a recent initiative has established semen and embryo banks. In 2001, 103 pure and 61 non-pure

Canadienne cattle were registered. The Canadien horse developed under the same conditions as the Canadienne cow, originating with importations from France starting in 1667. In 1995, 222 Canadien horses were registered, and this grew to 423 in 2001 (along with 98 non-purebred). The Newfoundland pony also developed in a harsh environment. It has never been recognized as a standardized breed and numbers declined greatly following agricultural mechanization. Today the Government of Newfoundland and Labrador is cooperating with private organizations to try to save the breed. There is unresolved controversy over the uniqueness of a "Newfoundland sheep" as well.

More recently, composite breeds, those produced by crossing of traditional breeds followed by selection for desired characteristics, have been developed and released in Canada. These include two breeds of cattle, four of sheep, one of swine, and one of chickens. Some commercial lines that would fit this definition of composite breeds are kept privately. Composite cattle breeds include the Hays Converter and the Shaver Beefblend. One composite breed of sheep that was produced by a Government of Canada breeding program (Rideau Arcott) is becoming quite popular, although two other Arcott breeds are increasing very slowly in popularity and another (the DLS breed) has never been used extensively. The Lacombe breed of pigs, developed by the Government of Canada in the 1960s, is now represented by only a few animals. Other lines of pigs that have been developed by private companies would likely meet the requirements for breed status, but are kept without registration. The Chantecler chicken was produced by a series of crosses between recognized breeds, and has survived on Quebec farms for about 80 years. Because of the length of time subjected to the influence of the environment, the Chantecler could be considered to be a Canadian landrace. It currently has no commercial importance.

Canada is also home to breeds that were developed elsewhere but are now of conservation concern. Most of these originated in the United Kingdom, and many are very ancient. Rare Breeds Canada monitors and assists in initiatives to maintain these breeds. The Rare Breeds Canada newsletter (Genesis) includes updated lists of breeds that they consider require conservation attention.

There are no feral cattle, sheep, swine, or chickens in Canada. The Sable Island horse, originating from an intentional introduction to this island off the coast of Nova Scotia about 1760, is now considered feral and is protected by a number of regulations. Feral populations of horses in Western Canada have recently received public attention, but have very recent origins and are not considered to be genetically unique. A few feral populations of goats exist on British Columbia coastal islands.

Canada has a limited number of wild relatives of domestic mammals. Native bison (*Bos bison*) are now being farmed commercially. There are also several kinds of wild sheep (*Ovis canadensis* and *Ovis dalli*) and a Rocky Mountain goat (*Oreamnos americanus*) but these are only distantly related to domesticated versions of sheep and goats. Elk (*Cervus elaphus*) and deer (*Odocoileus hemionus* and *Odocoileus virginianus*) are commercially farmed and populations of both species remain in the wild. Trapping of wild fur-bearing species, for example mink (*Mustela vison*), foxes (*Vulpes vulpes*), and Arctic foxes (*Alopex lagopus*) is an important industry for some northern peoples. Generally, wildlife industries are interested in maintaining the genetic integrity of stock, although some hybridization of plains and wood bison has occurred. In some provinces, exotic deer species and hybrids are not allowed. For example,

Alberta requires vasectomy or slaughter of wapiti stags showing blood markers suggesting hybridization with red deer.

Canada is home to some wild avian species that are distantly related to poultry. There are several native grouse and partridge species. Ring-necked pheasant (*Phasianus colchicus*), Hungarian partridge (*Perdix perdix*) and Chukar partridge (*Alectoris graeca*) were introduced to Canada and populations exist in a feral state. There are also small populations of wild turkeys (*Meleagris gallopavo*) which are likely a mix of wild and feral turkeys of North and Central America. The wild mallard duck (*Anas platyrhynchos*) and the domestic duck are closely related. Some species of wild geese are related to domestic geese kept in Canada.

Conservation efforts

Over the past decade, stocks of farm animals kept as pure lines in public institutions have largely disappeared. Agriculture and Agri-Food Canada maintained a large collection of genetic lines of poultry (chickens and geese) until 1995. A few of these are now kept by academic institutions or individuals. Direct federal and provincial breeding programs for cattle, swine, and sheep have been discontinued. The Quebec government has passed "an act respecting animal breeds forming part of Quebec's agricultural heritage", under which the Canadienne cow, Canadien horse, and Chantecler chicken are designated as Quebec heritage breeds, and it contributes to conservation programs for the Canadienne cow (both *in situ* and *ex situ*). The Government of Newfoundland and Labrador has legislation (Heritage Animals Act) to help Newfoundland breeds, and it lists the Newfoundland pony. Other provincial and the federal governments are not directly involved with conserving animal genetic resources, although some make limited contributions to agricultural museums some of which house heritage breeds of livestock.

At one time several Canadian universities kept collections of specific breeds of farm animals. In the past decade, the number of universities keeping these breeds and the number of lines kept by each have both declined. One university (University of British Columbia) formerly kept a collection of chicken and Japanese quail lines. These are currently kept by the Government of Canada at one of its research sites. Several universities including the University of Alberta and Nova Scotia Agricultural College keep lines of purebred chickens for demonstration and research. The University of Guelph has a collection of cryogenically preserved embryonic cells from the Agriculture and Agri-Food Canada lines, and the University of Saskatchewan has cryogenically preserved fibroblasts and DNA from the conserved chicken stocks previously held there. No Canadian university keeps breeding populations of endangered breeds of mammalian farm animals.

Rare Breeds Canada originated in 1986 as Joywind Farms Rare Breeds Conservancy, and became Rare Breeds Canada in 1995. This is a non-governmental organization concerned specifically with maintaining endangered breeds of farm animals. It is affiliated with Rare Breeds International, a network of grassroots organizations distributed around the world. Most animals are kept *in situ*, many in relatively small groups, and some bovine semen has been cryogenically preserved. In addition to its efforts at conservation *per se*, Rare Breeds Canada has played an important role in public education.

The Canadian Farm Animal Genetic Resources Foundation is also involved in promoting conservation of farm animal genetic variation. The Foundation focuses on raising the awareness of governments and industry and encouraging liaison with researchers.

Artificial insemination centres in Canada evaluate bulls and collect and freeze semen for sale domestically and internationally. All of the centres recognize that conserving animal genetic resources is important and routinely save frozen semen from tested bulls for conservation purposes. Private companies breeding other farm animal species (swine, poultry, and others) may keep some genetic material, especially if it has commercial benefit in the relatively short term.

Progress in characterization and evaluation of risks

The Government of Canada supports pedigree recording of farm animals. The "Animal Pedigree Act" regulates formation of breed associations and sets minimum standards for registration. Many breed associations maintain their own pedigree records. Agriculture and Agri-Food Canada, through the Canadian Livestock Records Corporation, maintains the General Studbook and Herdbook, which records information on animals that is not recorded by breed associations. The numbers of registrations for most livestock species represent only a small portion of the total population, but trends in registrations are indicators of changes in the population size of specific breeds.

In the 1990s, surveys of research animals, sheep, goats, swine and cattle in Canada were conducted by Agriculture and Agri-Food Canada. The surveys included a limited amount of information on production systems and merits. Surveys of poultry and laboratory animal stocks have been carried out by Canadian researchers, but are not currently up to date. Rare Breeds Canada monitors the number of individuals in breeds of farm animals of conservation concern, and has a limited amount of comparative production data on a few of these breeds.

The federal and provincial governments supported Record of Performance systems for dairy cattle and goats, beef cattle, swine, and sheep for many years, resulting in extensive characterization of growth and production traits and a more limited characterization of reproductive or other traits for the major breeds. In 1995 the Government of Canada privatized performance recording and genetic evaluation. The Canadian Dairy Network now coordinates performance recording for dairy animals, and the Canadian Centre for Swine Improvement has a similar role for swine. Some provincial programs for sheep performance recording still exist. Recording programs for beef cattle are done provincially or via breed associations, often in conjunction with programs in the United States. The Canadian Goat Society maintains its own performance recording for dairy goats.

In the last decade, there has been an increasing amount of research in molecular genetics of farm animals. This research, driven by individual researchers and funding agencies, includes genome scans for quantitative traits, sequencing of candidate genes, and development of markers for mapping. In a few cases the causative mutations for traits of economic importance have been found (ryanodine receptor in pigs associated with porcine stress syndrome, kappa-casein alleles associated with curding quality in cow's milk, leptin gene associated with fat metabolism in various species) and more have been mapped (horns and scurs in cattle).

Development of information systems for breed conservation

Rare Breeds Canada has developed systems to track endangered breeds of animals, but these are used almost entirely by hobbyists and small holders rather than the mainstream animal industries. Canadian Livestock Records Corporation and breed associations maintain pedigree records for purebred livestock, but the intent of this has not been breed conservation. Surveys carried out by Agriculture and Agri-Food Canada on research animals, sheep, goats, swine and cattle genetic resources need to be updated. At present, there is no comprehensive information system in Canada with a primary goal of breed conservation. One aim of the Canadian Farm Animal Genetic Resources Foundation is to ensure that inventories are revised annually and a goal of a national system will be to carry this out.

1.3 Assessing the state of utilization of farm animal genetic resources

Animal products have traditionally been marketed as commodities (eggs, meat, milk, fibre) which has encouraged use of the standard breeds, thus limiting the amount of genetic resources used in each species. Selection has been used to choose animals that produce the standard commodity in the most efficient manner in the standard industrial environment.

Canada's programs for pedigree verification, Record of Performance, and health of animals have produced significant export opportunities for Canadian animals because origins can be verified and levels of production and health status are high. Beef, dairy, swine, sheep, and horse genetic resources are exported, with relatively free movement of semen, embryos, and live individuals between Canada and other countries, especially the United States. As an indication of the importance of this trade, in 2001 the value of exports of beef genetics has been estimated by industry representatives at between $50 and $60 million. Exports of dairy cattle genetics are estimated by the industry to have a value of $100 million. In many breeds of farm animals, Canadian individuals form part of worldwide industrial populations.

There is currently market differentiation to identify beef and milk from specific breeds, animal products from sustainable alternative systems of production, and specialty wools for handicrafts. These marketing strategies may encourage the use of genetic variation in livestock populations because they market diverse rather than uniform products. The "alternative" market for animal products is currently small in comparison to the commodity market but is growing.

1.4 Identifying the major features and critical areas of farm animal genetic resource conservation and utilization

Governments and academic institutions have shown peaks of activity in farm animal genetic resource conservation, and have largely withdrawn from these as individuals have retired and programs have changed.

The animal industry must be concerned with economic viability, both short and long term. Their conservation of genetic resources within that framework must be in industries' commercial interest. Historically, the animal industries have considered that genetic diversity required for future change is available within the country or internationally and that it is generally uneconomical to maintain. Representatives of dairy, swine, poultry, sheep, and beef industries have recognized that genetic variation will be necessary for their industries to continue and expand, and have recently shown interest in participating in conservation activities.

Civil society is represented by Rare Breeds Canada and the Canadian Farm Animal Genetic Resources Foundation, which are both active nationally. La Societé des Eleveurs de Bovins Canadiens is incorporated under the Animal Pedigree Act - it operates principally in Quebec and receives some financial assistance from the Quebec government. It has directed efforts toward preserving the Canadienne cow by encouraging use *in situ*, cryogenically preserving genetic material, encouraging communication, and educating. The Newfoundland Pony Society receives some help from the provincial government. Farm museums in some provinces utilize animal breeds typical of the historical period they are portraying, but there is little or no coordination of these resources and often no contact with the civil societies involved in genetic conservation.

Conservation and use of animal genetic resources require funding, organization, and leadership. The measurement of genetic diversity of farm animal populations is essential for conservation and use. Conservation requires support from stakeholders: government, industry, academia, and producer groups.

Part 2. Changing and Growing Demands on the Farm Animal Sector and Implications for Future National Policies and Programs

2.1 Review of past policies, strategies, programs and management practices

At present Canada does not have a national program specifically for using and conserving farm animal genetic resources. However, Canadian government programs and regulations have influenced the availability of genetic variation and its utilization.

The Government of Canada Animal Pedigree Act

Canada's Animal Pedigree Act provides the legislative framework for incorporation of breed associations and gives the breed associations exclusive authority to operate national registries for animals. Registries under the act are operated by breed

associations or by the Canadian Livestock Records Corporation (previously Canadian National Livestock Records) which was established in 1905. A group of animals can be recognized as a breed under the Animal Pedigree Act based on three factors: a common genetic origin, distinctness, and genetic stability. Under the Animal Pedigree Act, "registered" and "purebred" are legally defined terms.

Registering an animal often represents a breeder's intention to use that animal in future breeding programs or to sell it as breeding stock. For most livestock species, only a small proportion of the animals in a population is registered. Registration makes pedigree information publically available and helps in the exchange of breeding stock domestically and internationally.

Registration of animals under the Animal Pedigree Act has contributed substantially to the success of Canada's animal industries, but the importance of animals registered under the Act to genetic progress varies between species. In dairy cattle, registration is widespread and selection progress is mediated through registered animals. The Canadian beef breeding industry is based largely on breeds recognized under the Animal Pedigree Act. Much of the selection progress in the sheep industry is mediated through animals that are registered under the Animal Pedigree Act. The mainstream swine industry has increased the use of hybrid parents in recent years. Many swine breeders register their breeding animals, but some large swine breeding companies now maintain breeding groups which may or may not be based on individual breeds, without registration. Commercial poultry are not registered in Canada; all commercial chickens and turkeys are hybrids purchased from international breeding companies.

Record of Performance programs

Canada has had significant Record of Performance programs which were used to rank the phenotypic performance of animals. The Record of Performance programs have contributed to the improvement of Canadian livestock herds by choosing the most productive individuals. Inevitably this has contributed as well to a narrowing of the genetic base when some individuals in a population were not used for further breeding, either because they were less productive in the environment used for the Record of Performance program, or because they did not conform to characteristics defined by the breed associations.

Performance recording programs have now been privatized. Breed associations for cattle and goats measure dairy performance. Beef breed associations also record performance, and several provincial governments operate record of performance programs for beef cattle. The Canadian Centre for Swine Improvement works with provincial governments to improve swine selection programs, and large breeding companies do extensive performance recording in-house. The Ontario and Quebec governments have provincial performance recording systems for sheep. Sheep producers may use software programs that include genetic analysis within a flock, but not between flocks. There is no public recording of performance for poultry.

Promotion of the purebred industry

Government programs such as Record of Performance have encouraged producers to buy purebred breeding stock, with a focus on genetic improvement to meet current and predicted future markets. Importation policies were significant in the establishment of national beef and dairy herds as Canada had been attempting to replace the existing stock with "improved" animals from elsewhere, principally Europe.

The effect of marketing boards

For the past several decades, governments have controlled importations of chicken, eggs and turkey and marketing boards have managed commercial domestic production. Poultry marketing boards have allowed the continuation of family owned and operated poultry farms in Canada, but the individual producers use terminal crosses purchased from international companies and do not control the genetics of the birds that they maintain. There has been some move by the poultry marketing boards to open the quota system to specialized products. However, the cost of quota generally limits the ability of conservationists to maintain breeding flocks. Some provincial marketing boards do support research in preservation of pure strains.

The dairy marketing system in Canada has produced stability in the industry by ensuring that producers receive an adequate return for their labour and their investments through a quota system. Orderly marketing has contributed to the domestic success of Canada's dairy industry and has had a significant impact on building the reputation of the Canadian dairy industry internationally, allowing the export of Canadian dairy genetics to more than 50 countries. Despite its remarkable success on a number of fronts, the dairy marketing system has not prevented the widespread use of a limited number of sires of only one breed, leading to inbreeding. Until 1992, the marketing system favored breeds producing high volumes of milk, discouraging commercial use of breeds producing milk with high solids content. The current system of paying for milk components may allow a limited increase in the use of other breeds.

Management practices

Canadian dairy, swine, chicken, and turkey industries use standard environments that require standard animals. Most dairy cattle spend at least part of their time outside. Most beef cattle are kept outdoors and are at least partially subject to vagaries of the environment. Industrial swine and chickens are kept in climate-controlled facilities. Most of the turkey industry also uses environmentally-controlled housing, but in some areas of the country part of the production cycle is outdoors. Small but growing sectors of the poultry and swine industries produce meat and eggs from animals with access to outside areas. The sheep industry is split; many producers use a high degree of management, with out-of-season lambing and multiple births, while others keep sheep on range, with a low level of management inputs.

Codes of practice have been developed for cattle, swine, sheep, bison, deer, and poultry, which provide recommended management standards for animal production and slaughter. These codes were developed with input from animal industries and groups concerned with humane treatment of animals and have been voluntarily accepted by producers. Producer groups have also developed on-farm food safety programs following Hazard Analysis of Critical Control Points (HACCP) principles, which have husbandry components. The HACCP programs are becoming important for the domestic and international animal industries. The growing trend towards greater awareness of animal welfare may lead to a need for more diverse genetics in the future if production environments change substantially as a result of consumer demands.

Genotype x environment interactions exist, and not all stocks respond equally well to intensive production environments. For example, some poultry stocks do not perform well in cage systems, and some selected for performance in cage systems will not

perform well in extensive systems. Some bulls do not respond to semen collection and storage, resulting in a potential loss of genetic variation. The processing environment also treats animals differently depending on their genotype. Processing facilities require animals that are uniform in size, carcass composition, and color, which encourages standardization of breeds and of animal types within breeds.

Government breeding programs

In the past, Agriculture and Agri-Food Canada has had formal breeding programs for poultry, swine (Lacombe), dairy cattle, sheep (including the Rideau Arcott, Outaouais Arcott, Canadian Arcott, and the DLS breed) and beef cattle. In 1988, Agriculture and Agri-Food Canada terminated remaining breeding programs, with the exception of the poultry programs which continued until the central facility was closed in 1995. Selected animals resulting from these breeding programs were dispersed. There remains an active research study on genetic strategies for sustainable production of livestock within Agriculture and Agri-Food Canada, but the results are transmitted to the industry as information on genetic improvement tools etc. rather than as genetically superior animals.

In the early 1990s, Agriculture and Agri-Food Canada established a Canadian Animal Germplasm Technical Experts Board. National and international workshops/symposia in areas related to animal genetic resources were held in 1990, 1993, 1994, 1997 and 1999. Since that time, the technical experts board no longer functions, although some individuals became members of the Expert Committee on Animal Genomics, Genetic Resources and Reproduction, of the Canadian Agri-Food Research Council. The technical experts board and the closely associated steering committee facilitated the formation of the Canadian Foundation for the Conservation of Farm Animal Genetic Resources, which is a non-governmental organization. This organization is currently known as the Canadian Farm Animal Genetic Resources Foundation.

National non-governmental organizations

Both the Canadian Farm Animal Genetic Resources Foundation and Rare Breeds Canada are national in nature. The Canadian Farm Animal Genetic Resources Foundation aims to promote and perform conservation activities through the coordinated action of industry, governments, and individuals. Rare Breeds Canada is a grass roots organization whose members maintain live animals at their own expense with the goals of rescuing and conserving breeds and educating the public.

2.2 Analyzing future demands and trends

Until recently, animal products have been marketed as commodities with little distinction between products by either producers or consumers. The commodity approach has encouraged a decrease in genetic diversity because the most efficient animals in a standard environment are used to produce a uniform product. Future needs may change depending on social developments (aging populations, changing income levels, environmental and animal welfare concerns), climate change, or changes in production environments, with subsequent changes in government policy and legislation.

Demand for industrial product

The demand for animal products in Canada is expected to remain strong. Domestic disappearance, representing total use, of beef and pork has remained steady or increased over the past 10 years on a total or *per capita* basis (Table 13) and is expected to continue this trend. Disappearance of mutton and lamb has increased over the last 10 years and is expected to continue this trend, providing increased opportunities for domestic producers. Consumption of chicken meat has increased dramatically over the past 10 years, a trend that is expected to continue, and total consumption of turkey meat has increased slightly. Total and *per capita* consumption of eggs has also increased over the past 10 years after a stable period lasting several decades.

Worldwide, Delgado (2001) predicted that between the early 1990s and 2020, meat consumption would increase by 2.8% per year in the developing world and 0.6% per year in the developed world. Canada has a worldwide reputation for superior breeding stock with a high health status and can expect to participate in the expanded domestic and international markets for animal products and genetics.

Increased niche marketing

In a small but growing trend, animal products are being sold under commercial brand names. Some of this marketing refers to post-slaughter treatment ("Air-chilled chicken", "Sterling Beef"), some refers to method of production ("Canada Organic", "Free Farmed") and some refers to specific breeds ("Certified Canadian Angus"). Niche market development can permit and even encourage the use of non-standard breeds that have specific characteristics and allow them to support themselves. Small cheese factories have been established that market cheese from specific breeds of cattle (including the Canadienne) to take advantage of characteristics of milk that are breed specific, such as the quantity and quality of protein contained. There is increasing use of goat milk for lactose-intolerant individuals. Most consumers can be expected to continue to purchase animal products as commodities, but others have demonstrated that they are willing to pay a premium for specialty products.

Use of animal products in industrial and non-food uses

Canada has seen a steady increase in development and demand for new animal products. Eggs are increasingly seen as an industrial product. Canada is home to one of the world's largest suppliers of extracted products from eggs (such as lysozyme, avidin, ovalbumin, and ovotransferrin) and eggs are used for the production of vaccines and antibodies. Other non-food uses include pregnant mare's serum gonadotropin which is used in the production of pharmaceuticals, and antlers which are used in oriental medicine. Biotechnology is contributing to the development of altered animal products for medical and industrial use. A growing market exists for neutraceuticals, which are food products with defined properties used to improve health and increase well-being. Some Canadian chickens now produce "Omega-3" eggs, which have high levels of alpha-linoleic acid and are marketed extensively in Canada, and researchers are defining strategies for dairy cattle nutrition to produce milk with altered levels of specific fatty acids.

Effects of government legislation and international agreements

Consumer concerns about food safety have resulted in increased regulation and monitoring of animal production. This has led to development of identification systems in the cattle industry to allow tracking of animals from point of origin, and to increased use of "Hazard Analysis of Critical Control Points" in, for example, the "Canadian Quality Assurance" program for swine. Legislation in some provinces governs manure application and land use for agriculture, and legislation in other provinces is anticipated.

International and regional agreements also reflect future demands and trends. Relevant international accords include trade agreements such as those relating to the World Trade Organization, intellectual property rights agreements, and multilateral environmental agreements such as conventions on climate change (e.g. methane emissions), desertification, and species at risk. Canada is party to the Convention on Biological Diversity, which includes provisions relevant to access to genetic resources and fair and equitable sharing of the benefits arising from their use. There is a growing tendency to negotiate multilateral solutions to global problems, and these must be implemented through action taken at national and local levels.

Alternative feeds and the effects of environmental change

Most commercial animal populations in Canada have been selected for production using standardized, high quality feeds. The use of alternative feedstuffs should increase because of population pressures, global warming, and an increasing awareness of the energy efficiency of animal production systems. Specific genetic traits will be needed in farm animals to allow them to use a variety of feedstuffs.

Climate change may modify the ideal characteristics of farm animals, increasing the need for hardiness, heat tolerance, and disease resistance. Even without climate change, our animal populations are always at risk from new diseases and specific disease susceptibility. Genotype x environment interactions need to be considered. The Holstein cow for example, while an excellent forage processor, may not be the breed best suited to a forage-gathering (i.e. pasture based) production system. Rankings of sire or dam lines within a breed may change with changing environment or production systems.

2.3 Alternative strategies for establishing a system to conserve animal genetic resources

Continue as we are

A continuation of Canada's present situation has the advantage of having no direct cost. The argument that Canada's animal industries are healthy and economically viable with the current system can be, and has been, used. This argument is valid in the short term.

Establish a government system

Governments could identify, fund, and manage conservation and utilization activities without industry participation, thus having complete responsibility for biodiversity activities. Government support and control has been seen as providing long-term security for the public good. However, it is noteworthy that a large portion of animal genetic resources is in the private sector and that current government approaches at all levels is for increased partnerships with stakeholders.

Encourage the private sector to maintain resources

Some may argue that the industry will benefit so the industry should pay. Others believe that ultimately it is the consumer that will benefit. Animal industries are concerned with short or medium-term goals and with corporate good. Corporate mergers often result in loss of genetic material as new managers modify strategy and consolidate genetic material in an effort to rationalize operations and reduce costs. Government funded economic measures to encourage industry to conserve material may become a concern in international trade negotiations if they are seen as trade-distorting subsidies.

Develop a collaboration of all stakeholders

Animal industries in Canada are concerned about conserving animal genetic resources, but they cannot plan or justify significant costs for the long term and do not necessarily act for the public good as each company is responsible to its owners. Collaboration and cost-sharing between government, industry, and civil society organizations allow for the elaboration of goals and approaches that would be mutually beneficial. Industry involvement would ensure a degree of economic viability, certainly in the short term, and government involvement would ensure that long-term goals were not ignored.

2.4 Outlining future national policy, strategy, and management plans for the conservation, use and development of animal genetic resources

Canada does not currently have a formal program for conservation, use, and development of animal genetic resources. However, there have been and continue to be activities and efforts towards such development. Having a program in place should allow for organization, information gathering and diffusion, animal rescue, and research in a coordinated fashion on a national basis. A national program may include some or all of the following elements:

- Strong leadership to ensure interaction and liaison with national and international stakeholders.

- An inventory of animal genetic resources, established and revised at appropriate intervals. Inventory to assess conservation status could include characterization of stocks with phenotypic descriptors, with molecular information added as it becomes available.

- An emergency rescue system, which could be activated in accordance with developed priority lists. Emergency rescue must be sufficiently funded, advertised, and able to react quickly.
- Ways and means to facilitate producers to maintain endangered breeds.
- Education, advocacy, and public awareness programs to develop and maintain broad support.
- Further research into preservation techniques, including cryogenic technology for species such as swine and poultry, molecular technology for most species, and research on management of small populations.

Part 3. Reviewing the State of National Capacities Related to Farm Animal Genetic Resources

3.1 Assessment of national capacities and capacity building

Human resources and infrastructure available

In Canada, no scientific personnel are directly allocated to farm animal genetic resources conservation and Canada has very little publicly-funded infrastructure devoted to the maintenance of these resources. Agriculture and Agri-Food Canada and the Canadian Farm Animal Genetic Resources Foundation recently initiated a process of forming a Steering Committee and developing a business plan with the intent to establish a program involving governments, the animal industries, and academia, to support conservation of farm animal genetic resources. There is no federal legislation specifically related to the conservation of farm animal genetic resources. The Experimental Farm Stations Act, which permits the establishment of farm stations across Canada, also charges the officers of these farm stations with the duty of conducting research bearing on the agricultural industry of Canada.

Canada has eight agriculture faculties that grant degrees, four veterinary colleges, and a number of technical colleges that grant diplomas in agriculture, animal science, or both. Most of these have some personnel with expertise in quantitative or molecular genetics or reproductive technologies that could be useful in conserving farm animal genetic resources. Current teaching programs in animal science offer at most one or two lectures on animal genetic resources conservation. Other faculties have science programs which include teaching and research in biology, biochemistry, molecular biology, and reproductive technologies. A few post secondary educational institutions have environmental sustainability programs which may include agricultural biodiversity sections. The need to distinguish wild and captive stocks has led to some research on genetic structure of species such as bison, wapiti and caribou.

One of Canada's federal agricultural research locations currently keeps several lines of chickens and Japanese quail. Several locations have programs in animal biotechnology and reproductive technology. The Canadian Livestock Records Corporation maintains pedigree databases and has expertise in this area. Some of the breed associations maintain pedigree databases either on their own or in collaboration with Canadian Livestock Records Corporation. The Saskatchewan Research Council, in collaboration with many of the purebred cattle associations in Canada, operates Bova-Can Laboratories at the University of Saskatchewan campus. Bova-Can Laboratories provides parentage testing using DNA technologies and cytogenetic analysis.

Canada's animal industries devote sufficient infrastructure to keep stocks of animals to serve their current development needs. Some companies keep a limited number of lines in anticipation of future needs. With rare exceptions, farm animals are kept for the sole purpose of ensuring future industry competitiveness with little or no concern for conservation itself.

The civil societies, Rare Breeds Canada and the Canadian Farm Animal Genetic Resources Foundation, provide frameworks for conservation but have limited facilities. Each has a communications network including a newsletter. A Rescue Network Plan (Crawford et al., 1995) was completed under contract to Rare Breeds International for the Canadian Animal Germplasm Technical Experts Board and could serve as the basis for a rescue network. Zoological societies and museums have some staff with conservation training, and private individuals have substantial interest and expertise.

Canada has free-roaming populations of native North American animals (elk, deer, bison) that are or could be farmed, which represent a significant source of genetic diversity. Public and private agencies are engaged in the conservation of native species in the wild and Canada's national, provincial, and regional parks and conservation areas are important for maintaining this diversity.

Human resources and infrastructure needed

A conservation of farm animal genetic resources program would require human resources and infrastructure to:

- Liaise with industry, academics, governments, and non-governmental and international organizations to link expertise and resources that are relevant to conserving farm animal genetic resources and serve as a conduit for international co-operation.
- Manage information, including development and maintenance of a database that can provide a linkage between existing databases and capture and store additional pedigree, phenotypic, and molecular information.
- Establish and manage cryogenic storage facilities and conduct and coordinate research on the development of new or improved methods of storing genetic information.
- Conduct research on genetic distance and the use of genetic diversity.
- Provide outreach programs and liaison with diverse groups, supplying promotional material and information to educational institutions, the general public and individuals requiring genetic advice on the management of small populations.
- Advocate for farm animal genetic resources.

The members of the program would need a broad understanding of genetics and expertise with agricultural species. They would need expertise in wildlife biology because of the interaction between farm animals and the environment, and because wild species such as elk, deer, and mink are currently being farmed. Expertise in the social sciences and economics is needed; for example, anthropologists may be called upon to ensure the involvement of local peoples with traditional knowledge of indigenous animal species. Marketing expertise would be needed to highlight the needs and successes of the program, and communications expertise would ensure that the issue of farm animal genetic resources receives adequate public exposure to maintain continuing support.

Infrastructure needed to conserve farm animal genetic resources in Canada includes:

- A physical location, although all components need not be in the same location.
- Information management resources to house pedigree, phenotypic, and molecular information and link existing databases.
- Laboratory space and cryogenic storage capacity for processing gametes for cryogenic storage where technology is available.
- Research capacity to develop new technologies for storage of genetic material and to investigate the nature, extent, importance and uses of existing genetic diversity.
- Animal holding facilities with defined health status to allow collection of gametes, support research, and as part of a rescue network.

At least three options exist on locating a farm animal genetic resources program.

- The program can be physically diffuse, without a central location but with many widely separate locations contributing to the program. This option has the advantage that some existing programs can contribute easily as individual parts of the program, but the disadvantage that it provides a weakened central focus.
- The program can have a central location with satellites. This option includes the advantages of a physically diffuse program without the principal disadvantage of a weak central focus.
- The program can have a single location. Whereas this option would provide an excellent focus and the best critical mass of personnel, it could ignore valuable human and physical resources that are available at other locations.

Part 4. Priorities for the Development of an Enhanced National Program of Sustainable Conservation and Utilization of Farm Animal Genetic Resources

4.1 National priorities for all species and interest groups

A national program would benefit the conservation and sustainable utilization of farm animal genetic resources. Facilities for keeping live animals could serve as part of a rescue network, allow collection of semen or tissue, and support a research program. Information systems and an emergency response system to coordinate rescue of specific groups of animals would be needed as part of a national strategy. Protocols for evaluation of specific populations would be needed to determine the level of support that will be provided. Methods of distributing technical information to interested groups would be essential.

Priorities as indicated by groups representing all of the principal species of farm animals include:

- Education and promotion of conservation with public, industry, and governments.
- Organization of information.
- Research on technologies useful for conservation.
- A system of rescue networks.

4.2 Priorities for specific animal species, breeds, regions and rural communities

Whereas action is needed to benefit all groups in a general way, there are also specific priorities for different groups of animals because the biology, commercial status, genetic status, and state of technological capabilities for each farm animal species are different.

Concerns and priorities by species

In beef cattle, the development of commercial lines without regard to breed and synthesis of new breeds is increasing. There are many beef breeds in Canada and some are represented by very small numbers of animals. In beef cattle, the most important need is for inventory, assessment, and cryopreservation of semen and embryos.

In dairy cattle there is increasing concern about the small number of sire lines that are now used in the national herd. Embryo and semen sexing will put additional pressure on genetic variation. Information is collected by the Canadian Dairy Network, breed associations, milk recording programs, and artificial insemination centres, and semen samples from bulls that are tested are routinely kept by artificial insemination centres. A national inventory of breeding stock should coordinate the data available, and cryogenic storage of genetic material should have national coordination and a common storage location.

Corporate control of swine breeding is increasing. Distinct breed populations are used extensively to create selected lines, either pure or composite. In pure lines, individuals are not necessarily registered. Systems are needed to permit adequate tracking of genetic origin and diversity in both large and small herds. Attention should be paid to preserving specific lines or breeds as standardization continues to reduce available genetic resources. Research on cryogenic storage of gametes is needed.

Breeding activities for the sheep and horse industries remain in the hands of individual farmers. Inventories are needed to establish what resources are available, particularly those that do not fit into the registration system and possibly in conjunction with broader performance recording programs. The goat industry in Canada is small and has a low visibility, but there are opportunities for growth. It is important to encourage maintenance of endangered groups of animals with significance to Canada, particularly in the sheep industry. Research is needed on reproductive technologies which will allow efficient freezing of semen and embryos.

Corporate breeding dominates the industry for chicken egg and meat production and for turkey meat production. Corporate mergers have created extreme concentration in the breeding industry, with associated concern about the effect on remaining genetic diversity. Inventories are needed for broiler and layer chickens, including inventories of stocks that are not part of mainstream agriculture but have good production under reasonably good conditions. Research into technologies such as DNA and fibroblast storage is needed.

Duck and goose breeding and production are on a small scale compared to those of chickens and turkeys. Inventories are needed, especially in relation to populations determined to be endangered and potentially useful.

Consumer demand for fox fur brings about cyclic production resulting in periodic major loss of breeding stocks. The situation is less extreme for mink, but inbreeding is commonly practiced in both foxes and mink, partly as a result of lack of breeder education. Characterization and inventories are needed, as well as research and liaison with other fur-producing nations.

Farm production of species native to Canada (bison and elk for example) is increasing, although the incidence of disease has presented a significant challenge. Inventories, followed by assessment of genetic diversity in relation to the wild population, are crucial at this stage of development of our interactions with these species. Liaisons must be developed with indigenous people involved in both wild commercial harvest and farm production.

Part 5. Recommendations for International Co-operation

Canada seeks stronger links with countries and regions that have similar production systems. For example, Canada seeks increased interaction with Nordic countries for fur species, and continued interaction with the United States for beef cattle characterization.

Canada seeks to cooperate with other industrialized nations, within North America and elsewhere, to ensure that farm animal genetic resources are maintained and available for use in intensive environments. This must include information sharing to avoid unnecessary duplication of efforts or misguided application of resources to groups of animals that are rare within a country but not on a world basis.

Canada seeks to cooperate with research communities in other countries to share research results and collaborate with other countries in the development and application of technology.

Canada seeks to continue and to enhance liaison with the FAO as the global leader in animal genetic resources utilization and conservation. Civil society organizations should be encouraged to continue and increase liaison with other similar organizations, including Rare Breeds International, in utilization and conservation of animal genetics resources.

Part 6. Other Elements

6.1 Preparation of the report

This report was prepared following the format and guidelines prepared by the FAO in their document "Preparation of the First Report on the State of the World's Animal Genetic Resources - Guidelines for the Development of Country Reports". In addition, S. K. Ho, D. L. Patterson, and F. G. Silversides attended a training session for Canada and the United States presented by FAO staff in Fort Collins, Colorado (USA) from November 8 to 10, 2001.

An *ad hoc* advisory committee of stakeholders was assembled in Saskatoon, Saskatchewan on November 24 to 25, 2001 where they presented their viewpoints. Subsequent to this, additional input was collected by e-mail, fax, mail, through telephone conversations, and personally, from *ad hoc* advisory committee members and others as necessary, and incorporated into a first draft. This was circulated to *ad hoc* advisory committee members on May 1, 2002.

An outline of the report and the process employed was presented to Canada's Subcommittee on Genetic Resources (Chaired by B. Fraleigh) of the Interdepartmental FAO Committee on March 13, 2002 in Ottawa, and again at another meeting of the Subcommittee on June 20, 2002.

Responses of *ad hoc* advisory committee members to the first draft were incorporated into a second draft which in turn was circulated to them for validation in July 2002. A telephone conference of the *ad hoc* advisory committee was held on August 7, 2002, and approval-in-principle was given to the document, pending final revisions. In addition, committee members asked that "A Call to Action" (Annex B) be included in the Country Report.

The draft report was submitted to the Minister of Agriculture and Agri-Food by R. D. Crawford, Chair of the *ad hoc* advisory committee on September 6, 2002. It was then reviewed and revised by the Subcommittee on Genetic Resources of the Interdepartmental FAO Committee.

6.2 Annexes

Annex A. Tables concerning animal production and use (from data provided by Agricultural Division, Statistics Canada, June, 2002)

Table 1: Land use in Canada

	Area (ha)				Trends in Area (ha)°		
Category	1991	1996	2001	2002	2003	2004	2005
Cropping for food	18,471,126	18,367,335	18,939,441	18,339,939	18,174,089	18,042,732	17,905,834
Cropping for feed	15,036 653	16,551,399	17,471,242	17,600,000	17,768,773	17,535,686	17,570,947
Natural pasture	15,963,299	15,612,162	15,397,640	15,371,842	15,347,842	15,347,810	15,323,288
Improved pasture	4,141,221	4,349,136	4,806,547	4,854,612	4,903,158	4,952,190	5,001,712
Fallow	7,920,948	6,260,725	4,682,396	5,100,000	5,220,093	5,180,111	5,150,000
On-farm forest and non-agricultural	6,220,452	6,914,200	6,233,988	6,144,265	5,899,340	6,181,993	6,192,109

°: Trends calculated using ratio of 2002/2001 data

Table 2: Human population in Canada

Year	Total	Rural	% Rural	Farming	% Farming
1991	27,296,859	6,389,724	23.4	865,895	3.2
1996	28,846,761	6,385,551	22.1	851,410	3.0
2001	30,007,094	6,098,883	20.3	Not available until 2003	
Average annual growth rate	1.0%	-0.5%		-1.7%	

Table 3: Importance of livestock to gross domestic agricultural production ('000 $Can)

	$ ('000)		
Activity	1991	1996	2001
Livestock production	11,081,805	13,845,011	19,534,447
Other agricultural production	8,892,383	14,098,448	13,958,504
Best estimate of additional value of livestock°	6,986	12,255	15,934

°: Estimated as 0.1% of value of livestock

Table 4: Land tenure for livestock production

	1991	2001
Category	% to total	% of total
Private	78.6	79.2
Government	21.4	20.8

Table 5: Farm structure and distribution

	1991				2001			
Category (ha)	Number of farms	% of total	Number of farms with livestock	% of farms with livestock	Number of farms	% of total	Number of farms with livestock	% of farms with livestock
< 3	11,848	4.2	6,618	4.6	31,981	13	23 264	16.6
3 to 9	14,657	5.2	8,083	5.6	17,991	7.3	11,178	8.0
10 to 49	52,959	18.9	30,981	21.4	30,275	12.3	18,647	13.3
50 to 99	55,372	19.8	33,971	23.5	48,766	19.7	29,645	21.1
100 to 499	110,015	39.3	52,799	36.5	37,432	15.2	21,349	15.2
> 500	35,192	12.6	12,288	8.8	80,478	32.6	36,346	25.9
Total	280,043		144,740		246,923		140,429	

Table 6: Farm size in Canada divided according to income source (for farms with gross farm receipts greater than $10K)

	1991		1999	
Income Source	Number of Farms	Average Farm Size, ha	Number of Farms	Average Farm Size, ha
>= 50% on-farm	123,905	387	96,790	424
< 50% on-farm	73,270	218	72,655	240
Excluded*	85	747	1,645	390
Total	197,260	324	171,100	346

* records where total income is 0 are excluded

Table 7: Income sources of farm families according to type of farm, 1999

	Number of families	Total off farm income	Net farm operating income	Total income	1998 to 1999
		$	$	$	% change
Business focused farms	77,260	38,098	28,162	66,261	2.2
Small	15,210	34,483	4,069	38,552	2.0
Medium	17,830	53,636	13,520	67,156	3.3
Large	41,120	32,679	39,799	72,478	1.5
Very large	3,090	38,367	76,499	114,866	-4.0
Other farms	74,580	53,001	5,033	58,035	1.8
Pension	34,450	43,213	12,831	56,044	1.5
Lifestyle	25,040	89,167	-3,017	85,150	1.3
Low-income	15,090	15,348	595	15,942	-5.2
Total	151,840	45,419	16,803	62,222	1.8

Table 8: Income from agriculture (farm cash receipts, '000 Can $)[a]

	Animals		Crops		Total	
	1991	2001	1991	2001	1991	2001
Atlantic Canada	396,533	607,925	505,428	673,925	901,961	1,281,850
Central Canada	4,236,543	7,444,687	5,427,798	7,144,146	9,664,341	14,588,833
Prairies	1,634,816	7,442,187	8,935,518	11,692,090	10,570,334	19,134,277
British Columbia	639,451	1,047,761	727,565	1,303,172	1,367,016	2,350,933
Total Canada	6,907,342	16,542,558	15,596,310	20,813,332	22,503,652	37,355,893

[a]: does not include program payments

Table 9: Livestock population, number of farms, and production, by species

	1991			2001		
Species	Population	Farms	Production	Population	Farms	Production
Cattle	12,972,038	145,747	865,952[a] 7,268,742[b]	15,551,449	122,066	1,249,956[a] 7,560,575[b]
Bison	15,775	285	NA*	145,094	1,887	72,402[a]
Sheep	935,891	13,114	10,421[a] 6,470[c]	1,262,448	13,232	12,946[a] 7,394[c]
Goats	88,116	7,735	2,798[a]	182,851	7,706	5,806[a]
Llama and Alpaca	2,028	266	NA	25,782	3,190	NA
Horses	356,204	58,509	NA	460,569	53,925	NA
Donkeys	8,398	1,413	NA	9,793	3,813	NA
Pigs	10,216,083	29,592	1,096,230[a]	13,958,772	15,472	1,729,127[a]
Chickens	94,872,875	42,661	600,516[a] 468,187[d]	126,159,529	26,484	926,843[a] 570,028[d]
Turkeys	8,076,808	8,462	130,934[a]	8,115,942	4,176	149,024[a]
Ducks	538,300	5,245	NA	1,251,609	3,324	NA
Geese	198,465	3,554	NA	129,799	1,889	NA
Rabbits	323,015	8,115	581[a]	255,762	1,874	460[a]
Mink	1,214,718	352	NA	1,349,412	218	NA
Foxes	30,369	719	NA	15,346	145	NA
Deer and Elk	29,527	461	NA	127,736	1,981	NA

[a]: meat, tonnes
[b]: milk, kilolitres
[c]: wool, tonnes
[d]: eggs, '000 dozen
NA: data is not available

Table 10: Distribution of livestock by production system and changes in distribution during last 20 years

	Production System*					
	Low input		Medium input		High input	
Species	%	Change	%	Change	%	Change
Cattle	0	_	51	0	49	+
Bison	0	_	57	+	43	+
Sheep	0	_	42	+	58	+
Goats	4	_	27	+	69	+
Llamas and Alpacas	24	0	19	0	58	0
Horses	6	0	44	0	50	0
Donkeys	62	0	38	0	0	0
Pigs	0	_	1	_	99	++
Chickens	0	0	4	0	96	0
Turkeys	0	0	1	0	99	0
Ducks	0	0	1	0	99	0
Geese	2	0	8	0	90	0
Rabbits	0	_	6	+	94	+
Wild Boar	1	0	48	0	51	0
Mink	0	0	2	0	98	0
Foxes	0	0	36	0	63	0
Deer	0	0	49	0	51	0
Elk	0	0	56	0	44	0

* The information contained in this table, relating to low, medium and high input production systems was prepared by the Livestock Estimating Unit, Agriculture Division, Statistics Canada in consultation with provincial agriculture statistical offices. Based on the interpretation of FAO's definition of the type of production systems, data from the 2001 Census of Agriculture were used to estimate farm size, the number of farms and the number of livestock. According to the farm size and provincial knowledge of the technology used, the production system was derived according to the input level. It must however be noted that Statistics Canada does not classify Canadian farms in this way. They are usually classified into small, medium and large operations based on the number of head, and this varies with the purpose, type of livestock and province. For example, the boundaries for sheep are: small operation, < 100; medium operation, > 100 and < 400 and large operation, > 400. Farms are also classified by the type of operation, for example: feedlots or finishing operations; cattle cow-calf operations or farrowing operations for hogs; back grounding operations, operations based on pasture and forage; specialized dairy operations; etc. Statistics per degree of specialization on the farm are also produced by looking at the main domain of agriculture income on the farm: milk; cattle; hogs; grains; etc.

Table 11: Major livestock primary products imports and exports (Source: International Trade Division, Statistics Canada)

	Imports		Exports	
Species	1991	2001	1991	2001
Cattle	217,372[a]	307,411[a]	105,262[a]	558,581[a]
	188[b]	251[b]	929[b]	1,320[b]
	44[c]	234[c]	NA[c]	NA[c]
Bison	NA	0[†]	NA	911[†]
				3[c]
Sheep	13,801[a]	18,191[a]	98[a]	299[a]
	28[c]	0[c]	23[c]	56[c]
	16,757[d]	1,398[d]	57,348[d]	85,630[d]
Goats	735[a]	756[a]	0[a]	0[a]
	2[c]	5[c]	0[c]	4[c]
	578[d]	1,935[d]	18,844[d]	18,229[d]
Horses	37[a]	NA	20,018[a]	13,336[a]
	74[c]	31[c]	9[c]	20[c]
	40,624[d]	NA[d]	NA[d]	NA[d]
Donkeys	NA[c]	0.3[c]	NA[c]	11[c]
Pigs	14,913[a]	89,475[a]	372,216[a]	730,949[a]
	1[c]	4[c]	1,066[c]	5,310[c]
Chickens	68,013[a]	151,683[a]	5,191[a]	99,495[a]
	23,178,656[e]	38,364,732[e]	3,239,483[e]	3,071,118[e]
Turkeys	5,320[a]	7,050[a]	6,851[a]	20,882[a]
Ducks, Geese and	NA	669[a]	NA	1,219[a]
Guinea Fowls		2,454[c]		433[c]
Rabbits	6[a]	NA[a]	4[a]	49[a]
		7[c]		
Veal	2,636[a]	2,445[a]	4,345[a]	3,877[a]

[a]: Meat, tonnes
[b]: Milk, tonnes
[c]: Animal, '000 head
[d]: Skins, number
[e]: Eggs, dozen
NA: data is not available
[†]: 2000 data

Table 12: Exports of genetic material (number of straws of semen and embryos) in 2001.

	Bovine*		Equine Semen	Porcine Semen	Caprine Semen
	Semen	Embryos			
Exports	2,452,991	2,337	364	859	50

* dairy and beef

Table 13: Demand for industrial product

	Domestic Disappearance			
	Total (tonnes)		Per capita (kg of carcass)	
Commodity	1991	2001	1991	2001
Beef	932,811	953,978	33.3	30.7
Veal	41,548	36,733	1.5	1.2
Pork	724,916	897,583	25.9	28.9
Mutton and lamb	24,332	30,836	0.9	1.0
Chicken meat	666,232	994,892	23.8	32.0
Turkey meat	127,300	130,384	4.5	4.2
Eggs ('000 dozen)	421,707	497,258	15.0	16.0

Annex B. A Call to Action from the *Ad Hoc* Advisory Committee

At a meeting held on August 7, 2002, the members of the *Ad Hoc* Advisory Committee agreed on the following text to be included in Canada's Country Report:

"Variation is the basis of genetic progress and Canada's animal industries must progress to allow them to compete internationally and to provide animal products for domestic markets. Highly efficient selection identifies the best animals for today's conditions. Other animals are eliminated, reducing genetic variation and Canada's flexibility to adapt to environmental and market changes and demands for new products. The Canadian government has acted in a timely and professional manner with respect to conserving Canada's plant genetic resources, and it is alarming that similar initiatives are not in place to conserve farm animal genetic resources. Canada must establish a time line for implementation of a plan to stem the erosion of farm animal genetic resources, and it must do so while variation still exists."

Annex C. Background documentation

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